7 Infrastructure

The DCR/MWRA Drinking Water Supply System is an engineering marvel. Starting with cisterns in colonial Boston, the system has grown to encompass lands and water over 100 miles to the west. The BWM Watershed System (Wachusett Reservoir, Quabbin Reservoir, Ware River and Sudbury Reservoir (the emergency supply)) delivers 250 million gallons a day to the MWRA to distribute through its transmission system to 47 communities. Continual inspections, maintenance and improvements are required in order to provide the consumer with clean, safe drinking water. The events of September 11, 2001 have raised additional security concerns which both agencies have addressed in their facility management. The MWRA and the BWM are completing a significant phase of infrastructure improvements, ensuring pure water for generations to come.

7.1 BWM Facilities

Accomplishments:
- Maintained the existing water supply dams and related hydraulic structures, bridges, roads and fire roads, and individual buildings and facilities.
- Constructed the Wachusett Reservoir Boat Cove Docking Facility in Clinton.
- Completed remedial repairs and improvements to the Beaman St. Bridge in West Boylston.
- Initiated underwater inspections of Wachusett Dam and Cosgrove Intake Facility.

Assessment:
Much of the infrastructure in the Wachusett Reservoir watershed is approaching 100 years in age. Maintenance of these facilities is crucial to the ongoing delivery of pure water to metropolitan Boston.

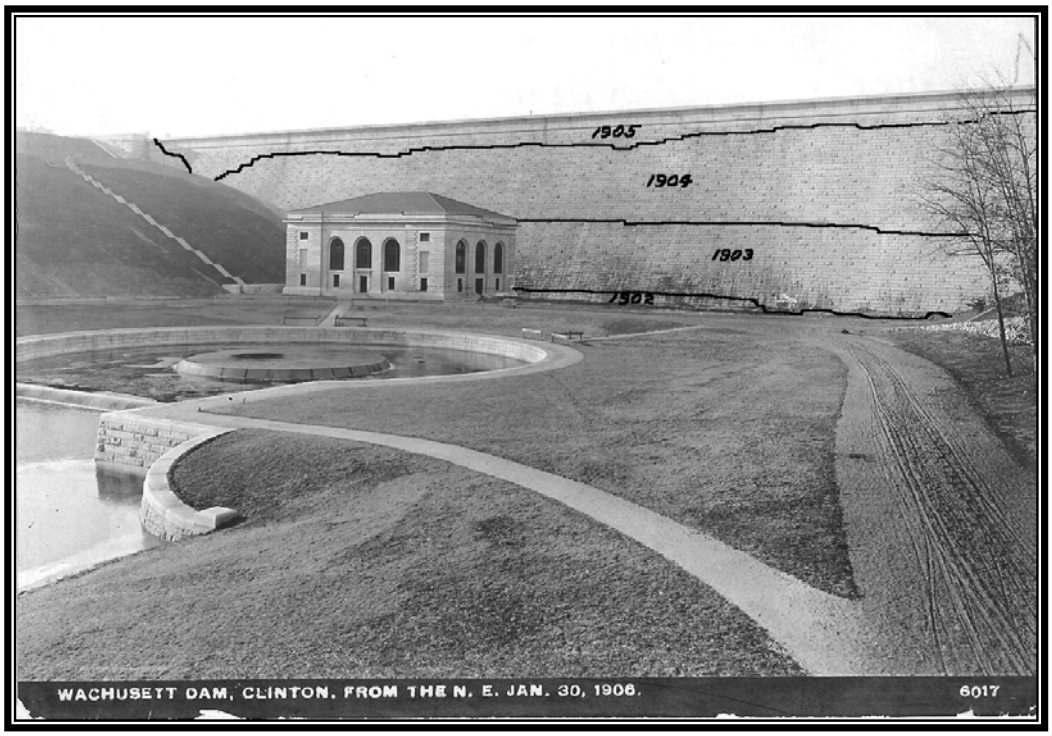
Key Actions:
- Complete underwater inspections of Wachusett Dam and Cosgrove Intake Facility; develop necessary repair designs from inspections.
- Proceed with Spillway improvements and North Dike modifications.
- Update existing Emergency Action Plans.
- Install specialized instrumentation and sensing devices at Bureau dams.
- Coordinate with MWRA on infrastructure projects.

Background

The Bureau of Watershed Management is responsible for six major water supply dams, six other major dams, 60 small dams, 419 miles of roads and fire lines, and 14 bridges throughout the watershed system (**see Fig. 1-1**). There are 65 separate facilities ranging from administrative offices to maintenance garages and storage sheds throughout the watershed system.

The dams that create the storage reservoirs are the heart of the watershed system. The dams associated with the entire active and active reserve elements of the water supply system include: the Winsor Dam, Quabbin Spillway and Goodnough Dike in the Quabbin Reservoir watershed; the

Ware River Dam and Intake at Shaft 8 in the Ware River watershed; the Quinipoxet Dam, Wachusett Dam and Spillway, North and South Dikes within the Wachusett Reservoir watershed; and the Sudbury, Stearns, Brackett and Foss Dams (the latter three often referred to as, respectively, Framingham 1, 2 and 3) on the Sudbury River. The reservoirs are connected by means of aqueducts that allow water to be transferred from within the watershed system itself and to the MWRA distribution system aqueducts and treatment facilities. Water is also supplied from Quabbin Reservoir to Chicopee and surrounding towns via the Chicopee Valley Aqueduct.



Historic photo demarcating annual progress of construction on Wachusett Dam, 1902-1905.

While the primary purpose of this extensive system of dams and reservoirs is to provide water supply, the dams and reservoirs are designed and operated as an integrated system with multiple objectives, including flood control, fish and wildlife propagation and aesthetics. The system is operated to:

- Optimize delivery of high quality water for drinking water supply.
- Ensure adequate volume in storage to respond to fluctuations in precipitation and demand.
- Meet downstream minimum flow release requirements.
- Prevent violation of minimum pool reservoir stage limitations.
- Maximize rainfall capture while minimizing spillage and control downstream flooding.

The system operates within a strict regime of regulatory and statutory constraints which dictate the operation and management of the system.

In addition to the major water supply dams in the system, there are approximately 60 other dams that perform various functions and fulfill a variety of needs at the local level, principally in terms of

flood control, recreation, fisheries and wildlife propagation, while also contributing to the operational reliability of the water supply system. Another benefit of the configuration and hydraulics of the system is the opportunity to generate revenue from hydroelectric power generation. Hydroelectric generating stations are located at the Quabbin Aqueduct Outlet at Oakdale and the Cosgrove Intake at Wachusett Reservoir; they are currently not in operation.

The Winsor (Quabbin), Wachusett and Sudbury dams fall into the "Large Size - High Hazard" category and are maintained and operated by BWM to meet Federal Energy Regulatory Commission (FERC) safety standards. The remaining dams are inspected and programmed to meet, at a minimum, the state's Office of Dam Safety standards, and, when practical, the higher standards set by the U.S. Army Corps of Engineers.

The BWM has a dedicated staff of in-house civil engineers who perform routine periodic inspections on a planned schedule for all dams within the system. In order to ensure compliance with stringent federal requirements, engineering consultants are employed to perform more in-depth investigations and studies of hydraulics, soils, and geo-technical conditions to guide major capital maintenance and repair projects.

Conditions affecting the operation of any of the Bureau's dams could result in a hazard to life and/or property due to high reservoir levels or a sudden release of large volumes of water. Emergency Action Plans (EAPs) describe in detail the overall duties and responsibilities of the operational and emergency personnel within the BWM as well as a general description of duties and responsibilities for other agencies, such as MWRA and the local community public safety agencies. The EAPs for Quabbin, Wachusett, Sudbury, and Framingham 1-3 all meet FERC requirements; all other impoundments' EAPs are prepared to meet U.S. Army Corps of Engineers' standards.

BWM is responsible for the planning, design and construction associated with dam projects. While establishment of dam and system operating policies is the responsibility of the BWM, operation of the water supply dams and system components is shared by the BWM and the MWRA. Flood control operations are also shared by the two agencies. Hydroelectric facilities are operated and maintained by the MWRA (revenues are paid to the General Fund by contracting utilities and offset MWRA's reimbursement for watershed management costs). Operations policies, communications and lines of authority are delineated in accordance with a Memorandum of Understanding between the BWM and MWRA.

Current Program and Accomplishments

The BWM is continuously inspecting, repairing and planning for future improvements to the existing water supply dams and related hydraulic structures, bridges, roads and fire roads, and individual buildings and facilities throughout the watershed system. Since 1998, the most significant capital improvements in the Wachusett Reservoir watershed have been the construction of the Wachusett Reservoir Boat Cove Docking Facility in Clinton and the completion of remedial repairs and improvements to the Beaman St. Bridge in West Boylston. The former was a $500,000 project to improve the facilities used by BWM staff to launch boats onto the reservoir for monitoring and wildlife management purposes (**see Sections 5.1.2 and 4.2.2** respectively).

BWM is conducting a system-wide program of underwater inspections and repairs of its dams and spillways. These repairs include both remedial efforts to prevent dam failure as well as the installation of state-of-the-art instrumentation. The results of the underwater inspections, along with those of the routine periodic inspections, will help determine any necessary repair work at Wachusett Dam and Cosgrove Intake Facility.

Wachusett Reservoir Boat Cove Docking Facility in Clinton.

Assessment

The watershed system's infrastructure is the product of more than a century of multi-purpose conceptualization, planning, design, construction and operating experience. The reliability and integrity of the system and its demonstrated ability to satisfactorily achieve the multiple purposes for which it was designed is unparalleled.

Much of the infrastructure in the Wachusett Reservoir watershed is approaching 100 years in age. Maintenance of these facilities is crucial to the ongoing delivery of pure water to metropolitan Boston. The ongoing program of Dam Safety will make planned improvements to the Wachusett Spillway and North Dike, as well as the installation of special monitoring devices, such as piezometers, inclinometers and wire strain gages. Due to the close relationship of the various facilities managed by the BWM and the MWRA, it is important that the two agencies effectively communicate on their different construction projects and revisions to the Emergency Action Plan in order to ensure that there are minimal impacts to water quality.

An emergency condition at the Wachusett Dam would require the coordination and cooperation of many government agencies, including the Wachusett/Sudbury Superintendent's Office, the BWM Headquarters' Office, the MWRA, and the police, fire and civil defense departments in many downstream communities that could be affected. Other involved agencies include the MA Emergency Management Agency (MEMA), the Massachusetts State Police, MA DEP, the U.S. Army Corps of Engineers, and the National Weather Service. The EAP describes in detail the overall duties and responsibilities of the operational and emergency personnel within the BWM as well as a general description of duties and responsibilities for other agencies, such as MWRA and the local community public safety agencies.

Control Approach

Goals

- To maintain the watershed infrastructure to ensure public safety, water quality and water supply.

Objectives

- Keep the watershed system's dams, dikes, roads and buildings in good, operating condition.

Action Items

- Complete underwater inspections of Wachusett Dam and Cosgrove Intake Facility; develop necessary repair designs from inspections.
- Proceed with Spillway improvements and North Dike modifications.
- Install specialized instrumentation and sensing devices at Bureau dams.
- Revise, as necessary, the Emergency Action Plan.
- Coordinate with MWRA on future infrastructure maintenance and improvement activities in order to minimize and mitigate any impacts on water quality and water treatment.

7.2 Security

Accomplishments:
- Expanded monitoring and hardening of components across the watershed system.
- Procured several response units for an accidental or intentional contamination of the reservoir, the watershed and its tributaries. Trained emergency responders, including local fire departments, BWM and MWRA staff, on the planned response actions.
- MWRA completed the Vulnerability Assessments and Emergency Response Plans on the entire watershed and distribution system as required by the 2002 Public Health and Bioterrorism Preparedness and Response Act.

Assessment:
The security of the metropolitan water system is of great importance. Since the terrorist attacks of September 11, 2001 a number of new operational policies have been enacted.

Key Actions:
Due to the sensitive nature of this matter, specific details are not included in this discussion.

Background

The terrorist attacks of September 11, 2001 forced all public water suppliers to focus their attention on the security of the water supply. Immediately following 9/11, the National Guard was deployed to guard critical components of the watershed system. The combination of specific physical improvements and the change in national security status has allowed many areas to re-open for public access; critical locations in the system, however, remain off-limits to the general public.

Current Program and Accomplishments

Several new operational policies have been enacted since September 11, 2001. Many changes in infrastructure security have also occurred, such as expanded monitoring and hardening of components across the system. BWM and MWRA have also completed procurement of several response units for an accidental or intentional contamination of the reservoir, the watershed or its tributaries (**see Section 6.3.2**). These units are specifically equipped for on-water, tributary and land-based deployment, and are prepositioned at strategic locations at each reservoir. Responders, including local fire departments, BWM and MWRA will deploy the equipment. A training component associated with the planned response actions was conducted in 2002.

On June 12, 2002 the Public Health and Bioterrorism Preparedness and Response Act became law. This law required all public water systems to complete Vulnerability Assessments (VA) on their systems. These VA's required the following:

- Characterization of the water system, missions and objectives.
- Identification and prioritization of adverse consequences to avoid.
- Determination of malevolent acts that could result in undesired consequences.
- Assessment of the likelihood of malevolent acts.
- Evaluation of existing countermeasures.
- Development of prioritized plan for upgraded to lower risk.

MWRA was the lead agency for this effort. Many months were spent on training of staff to perform the VAs, undertaking the actual assessments that systematically reviewed infrastructure components from the reservoirs through the distribution systems, and drafting the report. The final report was submitted to U.S. Environmental Protection Agency on March 31, 2003. An Emergency Response Plan (ERP) that focuses on malevolent acts was developed by the MWRA and certified by EPA in September, 2003. Detailed actions are considered sensitive to widespread distribution. There are separate plans developed for BWM specifically tailored for accidental transportation spills (see **Section 6.3.2**) and dam failure (see **Section 7.1**).

Assessment

BWM and MWRA consider security of the water system to be of the highest importance. Security of the water system must be comprehensive – source to tap – but flexible enough to adjust to a range of potential threat conditions.

Control Approach

Goals

- To provide a safe and secure water supply system.

Action Items

Due to the sensitive nature of this matter, specific details are not included in this discussion.